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Two new taxa close to *Lepiota cristata* from China

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Abstract — A new species, *Lepiota cristatanea*, is described from southwestern China. It is highly similar to *L. cristata* but can be distinguished by the relatively smaller basidiospores, Based on phylogenetic analysis, *L. fraterna* var. *macrospora* is transferred into *L. cristata*, becoming the only group in *L. cristata* with an abaxial and an adaxial knob on the spores.

Key word —*Agaricales*, *Agaricaceae*, lepiotaceous fungi, taxonomy

Introduction

Lepiota cristata (Bolton) P. Kumm. is one of the most widely distributed species in *Lepiota* (Pers.) Gray (Candusso & Lanzoni 1990, Bon 1996, Vellinga 2001a, Vellinga 2010). In the genus, the species is well known by the combination of its hymeniform pileus covering and truncate to spurred basidiospores. Additional taxa that share the two characters have been described from Europe, North America, and the southern hemisphere, such as *L. insimulata* E. Horak and *L. fraterna* E. Horak (Horak 1980); *L. castaneidisca* Murrill (Murrill 1912); *L. saponella* M. Bodin & Priou (Bodin & Priou 1994); *L. subfelinoides* Bon & P.D. Orton (Bon 1996); *L. cristata* var. *exannulata* M. Bon and *L. cristata* var. *pallidior* Bon (Bon 1981); *Lepiota cristata* var. *adextrinoidea* E. Valenz. & G. Moreno (Bon 1996); and *L. cristata* var. *viridispora* Kyde & J.L. Peterson (Kyde & Peterson 1986). *Lepiota cristata* and its allies form a well-circumscribed complex, inside which morphological variation may be remarkable or subtle.

In China, besides *L. fraterna* var. *macrospora* (Yang 1994), most collections with a hymeniform pileus covering and truncate to spurred basidiospores have been identified as *L. cristata*. However, our phylogenetic analyses show that the populations of "*L. cristata*" in China represent more than one species (Liang et

al. 2009). Moreover, sequences from a specimen identified morphologically as *L. fraterna* var. *macrospora* unexpectedly fell into the population of *L. cristata*. Morphological analyses of these sequenced samples thus produced one new species and new combination, which are described herein. This work helps clarify the circumscription of *L. crsistata*.

Materials & methods

Macro-morphological features were recorded in the field. Material was dried using an electric drier and deposited in the Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences (HKAS). Terminology for descriptive terms follows Vellinga (2001b). Color designations are from Kornerup and Wanscher (1981). Herbarium abbreviations follow Thiers (2011, continuously updated).

For microscopic observations, slides were made by hand and mounted in 5% KOH, Congo red, and Melzer's reagent. Basidiospores were mounted in cresyl blue to test for a metachromatic reaction (Singer 1986, Liang et al 2010). Size ranges were determined for basidia, basidiospores, cheilocystidia, and elements of the pileipellis, based on ocular micrometer measurements of at least 20 elements of each character. The abbreviation [n/m/p] indicates that measurements were made on n basidiospores in m basidiomata from p collections. Dimensions of basidiospores are given using a notation of the form (a–)b–c(–d). The range b–c contains a minimum of 90% of the measured values. Extreme values are given in parentheses. The following abbreviations are used: Q refers to the length/breadth ratio of basidiospores; **Q** refers to the average Q of all basidiospores ± sample standard deviation.

Taxonomy

Lepiota cristatanea J.F. Liang & Zhu L. Yang, **sp. nov.** Fig. 1

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Pileus initio subcampanulatus vel subconicus, deinde applanatus, albus vel sordide albus, squamulis brunneis vel brunneo-aurantiacis. Lamellae liberae, albae. Stipes subcylindricus, annulatus. Annulus superus, membranaceus, sursum sordide albidus, deorsum squamulosus. Basidiosporae subtriangulares, 4.0–5.5 × 2.5–3.0 µm, incoloratae. Basidia subclavata, 4-sporigera, raro 2-sporigera. Cheilocystidia clavata. Pleurocystidia nulla. Squamulae pilei ex hymeniformis clavatibus terminalibus compositae. Fibulae praesentes.

Type: China, Yunnan Prov., Kunming City, Kunming Institute of Botany, 3 VII 2006, J.F. Liang 306 (HKAS 50021, **holotype**).

Etymology: Named after its similarity to *Lepiota cristata*.

Basidiomata (Fig. 1A) small-sized. Pileus 1.5–4.5 cm in diam., at first subcampanulate or conico-campanulate, expanding to convex or applanate with obtuse umbo, at centre brownish (6D6-7) to orange brown (6C7-8), closed, smooth, around centre breaking up into concentrically arranged brownish (6D6-7) to orange brown (6C7-8) squamules on a whitish background. Context whitish, thin. Lamellae free, whitish, moderately crowded with lamellulae.

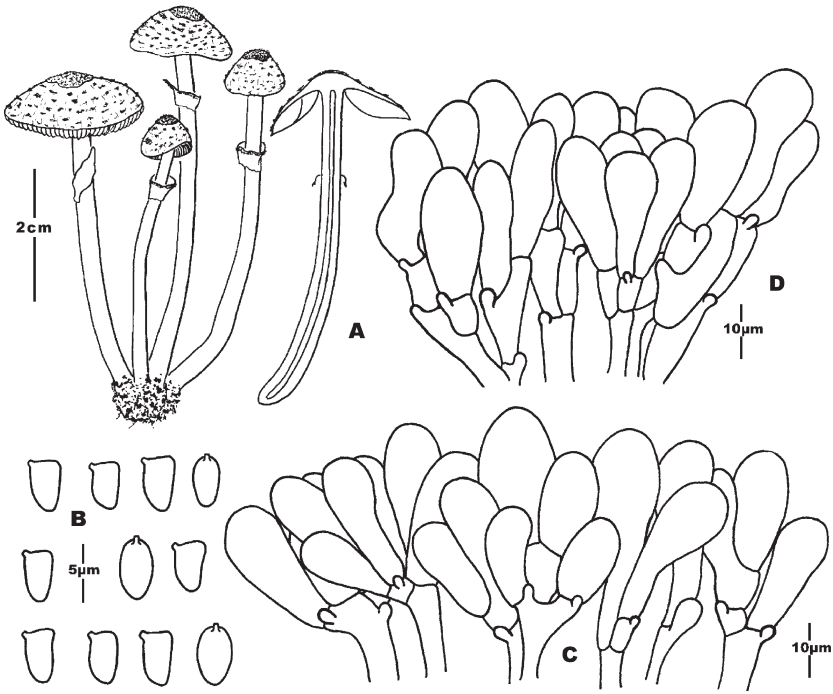

Fig. 1 *Lepiota cristatanea*: A. Basidiomata. B. Basidiospores. C. Cheilocystidia. D. Pileus covering. (A from HKAS 24828, B–D from holotype, HKAS 50021)

Stipe 20–55 × 2–7 mm, subcylindrical, attenuate, hollow, white fibrillose on pale orange (6A2-3) to grayish orange (6B3-4) background in lower half. Annulus membranous, superior, whitish on upper surface, with small brown to brownish squamules on lower whitish surface, easily broken during the expansion of pileus. Smell like *L. cristata*.

Basidiospores (Fig. 1B) [300/15/15] 4.0–5.5(–6.0) × (2.0–)2.5–3.0(–3.5) μm, Q = (1.33–)1.42–1.89(–2.00), **Q** = 1.65 ± 0.16, truncate or subtriangular in side-view, rarely with distinct spur, ovoid or oblong in front view, slightly thick-walled, hyaline, smooth, non-dextrinoid, congophilous but very weakly, reddish purple in Cresyl Blue. Basidia 13–18 × 5–7 μm, narrowly clavate, 4-spored. Lamella edge sterile. Cheilocystidia (Fig. 1C) 22–48 × 9–18 μm, clavate, colorless, hyaline, thin-walled. Pleurocystidia absent. Pileus covering (Fig. 1D) a hymeniderm made up of tightly packed clavate, narrowly clavate to cylindrical terminal elements of different lengths, 14–60 × 5–13 μm, with brownish intracellular pigment, slightly thick-walled. Clamp connections present in all tissues.

Additional specimens examined: **China**, **Yunnan Prov.,** Kunming, Kunming Institute of Botany, Chinese Academy of Sciences, alt. 1980 m, 2 VIII 2003, F.Q. Yu 1118 (HKAS 44607); 7 VIII 2003, H.C. Wang 368a (HKAS 42708a); 20 VI 1990, Zhu L. Yang 993 (HKAS 22657); alt. 1970 m, 12 VI 2003, H.C. Wang 261 (HKAS 44352); 19 VI 2003, H.C. Wang 273 (HKAS 44361); 19 VI 2003, H.C. Wang 271 (HKAS 44359); 6 VI 1991, Zhu L. Yang 1083 (HKAS 24829); 5 VII 1991, P.G. Liu 760 (HKAS 24827); Heilongtan Park, alt. 1900 m, 11 VII 1991, Z.L. Yang 1090 (HKAS 24828); Qiongzhu Temple, alt. 2100 m, 6 VIII 2006, J.F. Liang 456 (HKAS 50183); Jianchuan Co., Shibao Mountain, alt. 2400 m, 15 VIII 2003, Z.L. Yang 4028 (HKAS 43063); Eryuan Co., Lazapo, alt. 2900 m, 13 IX 1993, P.G. Liu (HKAS 26585); **Tibet Autonomous Region,** Longzi Co., Sananqu, Linlongzhan, 13 VII 1975, M. Zang 212 (HKAS 5212); 16 VII 1975, M. Zang 270 (HKAS 5270).

Habitat & distribution: Solitary or gregarious, saprotrophic and terrestrial, on humus-rich soils, often in footpaths and lawns of gardens or in forests, sometimes in open roadsides. Known from southwestern China.

Discussion: *Lepiota cristatanea* is characterized by its brownish to orange brown closed squamules at pileal centre, small truncate or subtriangular basidiospores, and the hymeniform pileus covering made up of tightly packed clavate, narrowly clavate to cylindrical terminal elements.

Lepiota cristatanea is "*Lepiota* sp. 2" in Liang et al. (2009). Though clearly separated from the core clade of *L. cristata* with high bootstrap value in all ITS, IGS, and mtSSU sequence analyses, the morphological differences between the two species is not so remarkable. The only reliable distinction is that the new species has smaller basidiospores and basidia, compared with those of *L. cristata* and its varieties and allies, such as *L. cristata* var. *exannulata* and var. *pallidior*, and *L. saponella.* This might explain why in China it has been passed under the name *L. cristata* for a long time.

In the *L. cristata* complex, smaller spores can also be found from *L. insimulata,* a species growing among litter of *Araucaria cunninghamii* in Papua New Guinea. However, our observation on the type of the New Guinean species found that it has broadly clavate to pyriform cheilocystidia. Other species with hymeniform pileus covering (e.g., *L. apatelia* Vellinga & Huijser, *L. cristatoides* Einhell., *L. hymenoderma* D.A. Reid) clearly differ from *L. cristatanea* because of their ellipsoid basidiospores (Vellinga 2010).

Several other species whose names are similar to *L. cristata* are also worth noting here. These species include *Lepiota cristatella* (Peck) Sacc. (Saccardo 1887), *L. cristatiformis* Murrill (Murrill 1946), *L. cristatoides* (Vellinga & Huijser 1998), *L. cristatula* Rick (Rick 1920), *L. subcristata* Murrill (Murrill 1911), and *L. subcristatella* Murrill (Murrill 1939). However, *Lepiota cristatanea* differs from these species by truncate or subtriangular spores but not ellipsoid to subellipsoid spores.

Due to its hymeniform pileus covering, *L. cristatanea* can be placed in *L.* sect. *Lilaceae* Bon (Bon 1981), *L.* sect. *Cristatae* (Kühner Ex Wasser) Bon (Bon 1993), or clade 3 of *Lepiota* in Vellinga (2003).

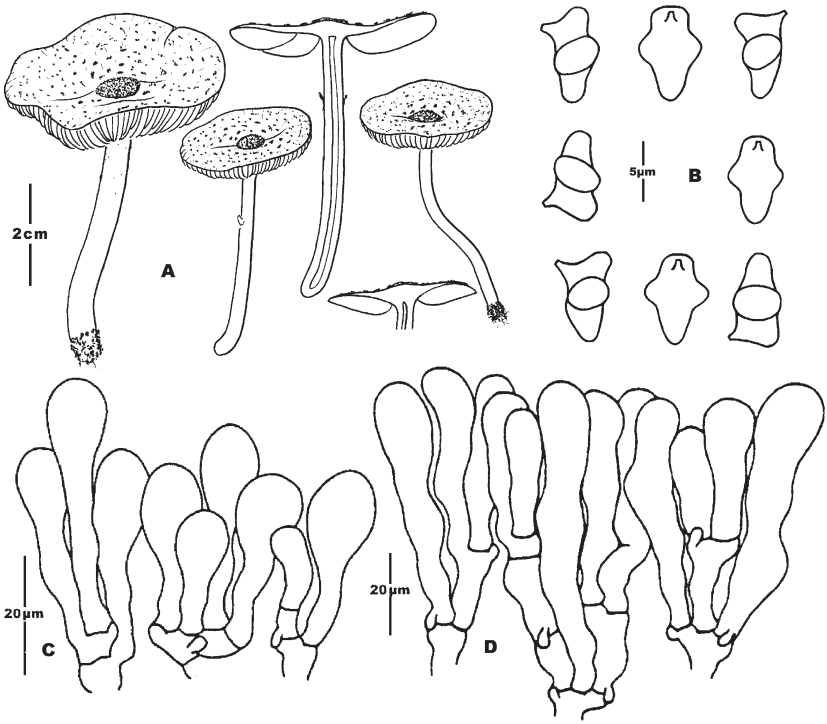

Fig. 2 *Lepiota cristata* var. *macrospora*: A. Basidiomata. B. Basidiospores. C. Cheilocystidia. D. Pileus covering. (A from HKAS 35988, B–D from HKAS 51356)

Lepiota cristata* var. *macrospora (Zhu L. Yang) J.F. Liang & Zhu L. Yang, **comb. nov.** Fig. 2

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≡ *Lepiota fraterna* var. *macrospora* Zhu L. Yang, Econ.Macrof. SW. China: 124, pl. 24/figs. 7–9, 1994.

Basidiomata (Fig. 2A) small-sized. Pileus 1.5–5 cm in diam., at first subcampanulate, expanding to convex with slightly inflexed to deflexed margin, with obtuse umbo, at centre reddish brown or brownish, closed, smooth, around centre breaking up into concentrical rings of reddish brown to brownish scales on a whitish background. Context whitish, thin. Lamellae free, whitish, crowded with lamellulae. Stipe 25–70 × 2–4 mm, subcylindrical, attenuate, hollow, white fibrillose on cream background below annulus. Annulus membranous, superior, whitish on upper surface, with small brown to brownish squamules on lower whitish surface, easily broken during the expansion of pileus. Smell like *Lepiota cristata*.

Basidiospores (Fig. 2B) [400/20/18] 6.0–8.0(–8.5) × 3.0–4.0(–4.5) μm, Q = (1.33–)1.56–2.33, **Q** = 1.92 ± 0.24, truncate and subtriangular in side-view, rarely with distinct spur, always with obvious lateral knobs on abaxial and adaxial sides, wedge-shaped with a lateral knob on each side in ventral view, slightly thick-walled, hyaline, smooth, non-dextrinoid, slightly congophilous, reddish purple in Cresyl Blue. Basidia 15–24 × 6–9 μm, narrowly clavate, 4-spored. Lamella edge sterile. Cheilocystidia (Fig. 2C) 20–42 × 7–15 μm, clavate, colorless, hyaline, thin-walled. Pleurocystidia absent. Pileus covering (Fig. 2D) a hymeniderm made up of tightly packed clavate, narrowly clavate to cylindrical terminal elements, 25–60 × 8–17 μm, with brownish pigments, and thick walls. Clamp connections present in all tissues.

Specimens examined: **China**, **Yunnan Prov.**, Kunming, Heilongtan Park, alt. 1900 m, 24 VII 1979, G.H. Feng (HKAS 4605, **holotype**); 22 VI 1982, D.G. Ji (HKAS 9728); 14 VII 1979, M. Zang 4446 (HKAS 4546); 13 VIII 1991, M. Zang 11884 (HKAS 23431); 11 VII 1991, Z.L. Yang 1089 (HKAS 24831); Kunming Institute of Botany, alt. 1980 m, 26 VI 2006, Z.W. Ge 59 (HKAS 45053); 21 VII 2005, J.F. Liang 119 (HKAS 48457); 13 X 2006, J.F. Liang 645 (HKAS 51356); 7 VIII 2003, H.C. Wang 368b (HKAS 42708b); 13 VIII 2003, H.C. Wang 371 (HKAS 42710); 5 VI 1991, Z.L. Yang 1084 (HKAS 24830); 19 VII 1991, Z.L. Yang 1098 (HKAS 24842); 26 VI 2000, Z.L. Yang 2897 (HKAS 35988); 28 VI 2004, Z.L. Yang 3958 (HKAS 45049); 8 X 2005, Z.L. Yang 4608 (HKAS 49449); West Mountain, 11 IX 1993, Y. Doi (HKAS 26553); Lijiang, Yulong Mts., Heibaishui, 28 VII 1995, M. Wang 1(HKAS 29994). **Beijing Municipality,** Wanshou Mountain, Chinese Academy of Forestry, 12 VII 1986, G.C. Bi 8611 (HKAS 2522); Gansu Prov., Diebu Co., Baiyun Bureau of Forestry, alt. 2200 m, 3 IX 1998, M.S. Yuan 3649 (HKAS 33586).

Habitat & distribution: Solitary or gregarious, terrestrial and saprotrophic, on humus-rich soils, often in footpaths and lawns of gardens or in forests, sometimes in open roadsides. Common in southwestern China, rare in northwestern and northern China.

Discussion: *Lepiota cristata* var. *macrospora* is characterized by its reddish brown to brownish closed squamules at pileus centre, truncate or subtriangular basidiospores with lateral knobs on abaxial and adaxial sides, and hymeniform pileus covering made up of tightly packed clavate, narrowly clavate to cylindrical terminal elements.

Lepiota cristata var. *macrospora* was originally described as *L. fraterna* var. *macrospora* based on its similar appearance to *L. fraterna* (Yang 1994). In the phylogenetic tree of *L. cristata* (s.l.), however, specimens identified as *L. fraterna* var. *macrospora* based on morphological characters form a terminal and well supported clade within *L. cristata* (Liang et al. 2009). Nevertheless this broadens our understanding on the morphological circumscription of *L. cristata.* Due to its uniquely shaped basidiospores, this new combination is proposed here for convenience. The variety epithet "*macrospora*", that suggested relatively bigger spores compared with *L. fraterna* var. *fraterna*, is retained

only for nomenclatural reasons, as basidiospores of *L. cristata* var. *cristata* and *L. cristata* var. *macrospora* are in fact undistinguishable in size.

Lepiota cristata var. *macrospora* differs from other varieties, such as *L. cristata* var. *cristata*, *L. cristata* var. *pallidior, L. cristata* var. *exannulata,* etc., by its basidiospores with lateral knobs (see Bon 1996).

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